Stress and Performance

Sponsored by The Office of Naval Research

Hosted by Dr. Seymour Levine, Stanford University

San Francisco, CA Dec. 2-4 1990

Final Report

Purpose: The purpose of this conference was to provide an interdisciplinary forum that brought together scientists with different approaches and perspectives on the study of stress and its relationship to performance. The goals were to present new ideas and approaches that might have an impact on future directions of research on the effects of stress on human behavior in general and more specifically on human performance, in keeping with the interests of the Dept. of the Navy. The participants of this conferences were chosen to represent the major disciplines that have investigated some aspect of stress, either biologically or psychologically. The specific participants were selected by the host of the conference and by members of the ONR staff. The format of the conference was to focus more on discussion of research problems rather than on data presentation. This meeting was also designed to act as a tutorial for the ONR staff attending the conference.

Format: The conference was held over two days, with a morning and afternoon session on each day. Each session featured a keynote speaker who presented a

session on each day. Each session featured a keynote speaker who presented a general orientation to the topic of the session. Following this presentation , a small panel of 5-6 participants initiated a discussion and addressed issues germane to the topic. Prior to the meeting a series of general question were prepared by the ONR staff and were to be dealt with by the panelists. Although these questions were designed to provide some structure to the discussion in actuality the discussion was generated as much by the audience as the panelists.

Sessions Summary: It is not an easy task to reconstruct the exact contents of each session nor to detail the entire discussion. Thus the essence of this report will be to give a brief overview of the intent of each session and to comment on questions addressed.

Sesion 1: The Biology of Stress

The purpose of this discussion was to examine the current state of the art with regards to some of the biological markers of stress. In particular some of the key endocrinological and neuroendocrinological processes were discussed. The more recent advances in the field of immunology and the effects of stress on immunological function was another central theme of this session. Due to the historical emphasis placed on the Hypothalamic-Pituitary- Adrenal system as one of the principle endocrine responses to stress it is not surprising that much of the

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Conference was intended to bring together scientists from different disciplines in order to exchange perspectives on the study of stress and its relationship to performance.

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December 23, 1991

Dr. Terry Allard
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Dear Terry,

As you can see I have completed what appears to be a final report on the " Stress and Performance" conference (Grant # N00014-91-J-1147). Since I have not written a report of this kind I trust that I did include all of the required information. As you will see I could not resist some editorial comments. Clearly if one were to do this again it would most likely not take the same form. However in retrospect I think it was useful and some important questions were generated. You might like to know that Dick Thompson and I are about to resume our collaboration on the stress and LTP problem. Although Tracy Shors has moved on there is new Post-Doc who we will work with. One of the very nice side benefits of this conference was having the chance to work with you. I want to thank you for all your help and concern about this undertaking. I trust we will keep in touch and if I can be of any service in the future please do not hesitate to call on me.

Sincerely,

Seymour Levine

cc ONR ✓
SPO

discussion centered on cortisol,ACTH, and the neuropeptides CRF and Vasopressin. However the effects of stress on the endogenous opioid systems was also included. That stress influences numerous aspects of immune function was amply demonstrated. A central issue which invariably arises when discussing the biological indices of stress is what is the best and most sensitive measure of stress. As would be expected this issue was not resolved on this occasion primarily because it is not resolvable. Resolution of this issue would require a unitary concept of stress, and if there is one profound conclusion from this conference is that such a unitary definition could not be agreed upon.

Session 2 : Performance Aspects of Stress

In this session the emphasis was on the effects of stress on various aspects of performance which included perceptual-motor and cognitive operations. Although the major emphasis was on human performance data on animals models was included. The issue of stress and performance is of great importance to the military. It is difficult to conceive a situation that is more stressful than combat conditions. However in this age of high technology weaponry fine tuned performance is required and perhaps of more importance life and death cognitive decisions are being made under extremely stressful conditions. What emerged from this session was that indeed performance was effected by stress. However, whether performance was impaired or enhanced depended upon numerous and many as

yet unspecified variables. Amongst the variables which predicted the direction of the influence of stress on performance was the nature of the task, the background of the individual performing the task, the intensity of the stress, and the degree of real or perceived control over the stress situation. What emerged from the discussion is that 1) At this time the only conclusion possible from the existing data is that stress does affect and under certain conditions it can impair performance and 2) It is difficult to specify or predict accurately whether stress will impair or improve performance. It does appear that this is one of the critical questions that should addressed in the future.

Session 3 Comparative Approaches

Although one of the purposes of this discussion was to attempt to bridge the gap between human and animal research much of the information imparted in this session was related to a discourse on new techniques for studying the human brain and how these are related to stress and emotions. In particular data on the use of PET scan and complex new EEG methodologies was presented. There is little question that these techniques show a much promise as an approach to studying changes in the brain during affective states in normal conscious human. However the major questions were related to the practicality of the methods for large scale studies. Of special interest during this session was a discussion of a sophisticated

new methodology for studying cognitive processes in non human primates. This technique was demonstrated in a video tape and was one of the highlights of the conference. This procedure involves using a video screen with complex problems which can be solved by the monkey using a joy stick. It was apparent that these primates are capable of solving very complex problems. It seems highly likely that a research program which combines biological manipulations and measurements with these behavioral paradigms could approach the issue of stress and performance in an exciting and systematic way.

Session 4: Diagnosis of Stress Traits

This session discussed one of the critical questions which bears directly one the issue of personnel selection. The question that was addressed concerned whether there were individual differences in the biobehavioral response to stress and whether these represented trait as opposed to state differences. The importance of this question is self evident. If such trait differences exit it should be possible to create selection procedures that would prevent placing a highly stress prone individual in a decision making position that would require that person to have to function in a high stress situation. Although the question was posed the answers were only suggestive. Data were presented which did indicate that in humans certain test procedures may be of value in predicting the response to

stress in a particular individual. Specifically the Stroup defence mechanism test seems to be able to predict stress reactivity. In humans it is possible to identify individuals who have good or bad coping skills on both a behavioral and physiological profile and these responses appear to be reliable over time. However this information does not address the issue of whether these characteristics are genetically or environmentally determined. Data was presented that would suggest that in non human primates the pattern of stress responsivity may be due to genetic factor. There is significant literature in rodents that the pattern of stress responses can be selectively bred for. Further, stress responsivity can also be altered by experiential means such as exposure to stress during critical periods in development, or experience with uncontrollable stress at almost any time during the organisms life span. There is no question that an important source of variance in studying any aspect of stress and performance is the idiosyncratic nature of the stress response and in order to identify these differences new approaches both psychometric and biological need to be determined.

Critique

It is not an easy task to critique any conference and to evaluate what has been accomplished, both in terms of the dissemination of new information and whether the discussions achieved the goals established by the staff of ONR.
In the case of this particular meeting there was a problem in that the participants

represented such disparate disciplines making communication difficult. Thus,although there was represented amongst the participants an outstanding group of investigators from multiple disciplines, the methods and concepts did not always appear to cross disciplinary barriers. This was particularly evident between the biological and psychologically oriented disciplines. However in spite of this difficulty which is perhaps inherent to any interdisciplinary conference what did emerge was a series of provocative discussions which raised important research questions germane to the issue of stress and performance. The issues which confront the field at this time are many and the field would be well served if at some time decisions can be made concerning 1) the best way to measure stress, 2) to specify what aspects of cognitive operations are influenced by stress and 3) to determine whether there are specific selection criteria which could predict individuals which are most likely to show impaired function under stressful conditions.

STRESS AND PERFORMANCE CONFERENCE

SIR FRANCIS DRAKE HOTEL
SAN FRANCISCO, CALIFORNIA
DECEMBER 2 - 4, 1990

Sponsored by
Office of Naval Research (ONR)
Hosted by
Dr. Seymour Levine, Stanford University

The purpose of this conference is to provide an interdisciplinary forum that will bring together ıntists with different perspectives on the study of stress. Our hope is that new ideas and approaches be developed for studying the effects of stress on human behavior that must be understood to ɨimize performance of Navy personnel. In addition, this meeting will serve as a tutorial for ONR staff the development of future program initiatives.

The meeting will take place over two days, with a morning and afternoon session on each day. ɔh session will feature a single keynote speaker whose task is to present a general orientation to the ic of the session, emphasizing key concepts necessary to permit the uninitiated to contribute to the ɜuing discussion. Following the overview presentation, a panel of 4-5 participants will then initiate the cussion by addressing designated issues germane to the topic.

December 2, 1990
OPENING RECEPTION 7:00PM - 9:00PM
CHART ROOM

December 3, 1990
MORNING SESSION 9:00AM - 12:30PM
CYPRESS ROOM

ʳoductory Remarks: Steven Zornetzer, Director of Life Sciences, Office of Naval Research

ssion 1: **The Biology of Stress**
Chairperson: Terry Allard, Office of Naval Research

eaker: Seymour Levine, Stanford University
Pituitary-Adrenal System and Behavior: From Rodents to Primates

nelists: Christopher Coe, University of Wisconsin
Adrian Dunn, Louisiana State University
Michela Gallagher, University of North Carolina
George Solomon, University of California, Los Angeles
Joan Vernikos, NASA Ames Research Center

Discussion questions:

A) What behavioral paradigms are used to induce stress? Do different stressors have equivalent physiological effects?

B) How are different responses to different stressors measured?

C) What evidence exists for single vs. multiple systems mediating stress reactions? What are their neural substrates?

D) What are the differential effects of acute vs. chronic stress?

E) What neural mechanisms underlie putative perceptual, motor and cognitive effects of stress?

December 3, 1990

AFTERNOON SESSION 2:00PM - 5:00PM

Session 2: **Performance Aspects of Stress**
Chairperson: Willard Vaughan, Office of Naval Research

Speaker: Glyn Robert John Hockey, University of Sheffield, England
Human Stress Research: Current Perspectives and New Directions

Panelists: Janis Cannon-Bowers, Naval Training Systems Center
Paul Costa, National Institute on Aging
Michael Davis, Yale University
Douglas Derryberry, Oregon State University
Marcel Just, Carnegie-Mellon University

Discussion questions:

A) What causes stress in humans? How is it measured?

B) What reflexive, perceptuo-motor, and cognitive operations are affected by anxiety-induced stress states (e.g., startle, perceptual narrowing, decision making)?

C) Do different behavioral paradigms induce comparable physiological stress states?

D) Do different stressors have equivalent effects on performance?

E) Can a single stress-induction paradigm with documentable physiological effects be designed to study diverse perceptual and cognitive effects?

F) What are the differential effects of acute vs. chronic stress states on performance?

December 4, 1990
MORNING SESSION 9:00AM - 12:00NOON

n 3: **Comparative Approaches**
Chairperson: Susan Chipman, Office of Naval Research

er: Wayne Drevets, Washington University, St. Louis
Using Positron Emission Tomography (PET) to Study Emotion

ists: Patricia Carpenter, Carnegie-Mellon University
Alan Gevins, EEG Systems Lab, San Francisco
Duane Rumbaugh, Georgia State University
Robert Sapolsky, Stanford University
Donald Tucker, University of Oregon

ssion questions:
A) What is the relationship between PET studies and known neural mechanisms of stress?

B) What other physiological measures and behavioral paradigms can be used to study stress responses in humans?

C) What is the relevance of animal studies to human stress studies?

December 4, 1990
AFTERNOON SESSION 2:00PM - 5:00PM

ion 4: **Diagnosis of Stable Stress Traits**
Chairperson: Joel Davis, Office of Naval Research

aker: Holger Ursin, University of Bergen, Norway
Stable Traits for Selection for High Risk Occupations

alists: Richard Davidson, University of Wisconsin
Stephen Porges, University of Maryland
Stephen Suomi, National Institute of Child Health & Human Development
Ross Vickers, Naval Health Research Center

ussion questions:
A) Are behavioral and physiological responses to stress stable over time within individuals?

B) What psychological or physiological markers are available to predict specific responses to different classes of stressors?

C) Can stress traits be measured and used to predict stress effects on behavior and performance for specific individuals?

D) What are the practical implications for selection and assignment of personnel to specific jobs in the Navy and in industry?

ALPHABETICAL LIST OF PARTICIPANTS

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